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So far, then, as the author sets up pretensions to give us a philosophy of any kind, his volume deserves only adverse criticism; in fact, it would be beneath criticism in this respect did it not exemplify a frequently recurring tendency on the part of many scientists to construct their philosophy by generalizing from what is really evidence on only one side. However, if we disregard the author's philosophical pretensions, and consider his volume as what it for the most part really is, viz., a history of astronomical discovery, written in a style unusually clear and interesting and portraying facts which will set the lay-reader to thinking, then only praise is due him for his endeavor, and may his reappearance in the two volumes on *The Mechanism of Life* and *The Social Mechanism*, which he announces, be an early one.

E. G. SPAULDING

The Sense of Touch in Mammals and Birds, with Especial Reference to Papillary Ridges. By WALTER KIDD, M.D., F.Z.S. London, Adam and Charles Black. 8vo, pp. 176; 164 illustrations.

This work, although hardly of sufficiently broad scope to justify its main title, since it treats of only a very limited region, still contributes much to our general knowledge of the character of the skin which covers the ventral chirodial surface.

After a brief introductory chapter, in which the author explains the general plan of the work, and reviews the scientific literature already published upon this subject, Dr. Kidd proceeds to the discussion, which he divides into three parts, (I.) the macroscopical, (II.) the microscopical and (III.) the physiological study of the volar and plantar skin. This work comprises a study of 86 species of mammals representing 59 genera and 9 orders; also one species each of 11 genera of birds.

The varieties of skin are classified somewhat arbitrarily as follows: *leading types*, (1) smooth epidermis, (2) corrugated epidermis, (3) scales, (4) nodules, (5) hair, (6) rods, (7) papillary ridges; *mixed types*, (A) epidermis more or less corrugated, with coarse transverse ridges on the digits, (B) corrugated

epidermis with papillary ridges, (C) nodules with papillary ridges, (D) hair with coarse transverse ridges and smooth pads. Practically no attempt is made, however, to show any morphological relationship between these various types, a phase of the investigation which would be of the greatest interest and value.

Careful descriptions are given of each species studied, and the descriptions are accompanied by many diagrams. Especial attention is given to the occurrence of the papillary ridged type of skin. This type the author finds, as have other investigators, partly covering the volar and plantar surfaces of a few of the marsupials, rodents and carnivores and of all of the prosimians; but it is in the primates that the development of this form of skin becomes so complete and universal that it is justly designated "a character of ordinal rank." However, Dr. Kidd's statement that "of course, its highest development is found in the hand and foot of man," is plainly refuted by his own excellent diagrams showing the far more highly developed patterns upon both the volar and plantar areas of monkeys, particularly below the anthropoids. Indeed, one can but see in this statement the effect of a strongly preconceived idea that the ridges and the patterns which they form are, as the author attempts later to prove, purely tactile in function, and that he assumes that they must, therefore, reach their highest development in man. As a matter of fact, in the case of the hand of man, where certainly the tactile function is most highly developed, patterns are so seldom found, except upon the apical pads, as to argue conclusively that the patterns which appear in the lower monkeys and to a certain extent in other mammals are directly associated with and determined by external pressure upon the walking pads or elevated areas, upon the surface of which they are developed.

Part II. furnishes descriptions, with illustrations from photographs and drawings, of sections through many varieties of volar and plantar skin. If these illustrations were accompanied by interpretations pointing out clearly the various features shown, they would

be a most valuable addition to our knowledge. Unfortunately, we are left in doubt as to these points.

Further, in view of the fact that the whole treatise is upon the subject of the sense of touch, there is a singular lack of all study or delineation of the nerve supply to the skin and the nature and distribution of nerve endings. This study the author says is not necessary to the present treatment of the subject; and yet later he bases his argument that the ridges are tactile organs upon the arrangement of the papillæ of the corium, which he at the same time admits are, many of them, merely vascular networks. It would seem that the elaborate and careful work already done by Dogiel and others upon the nerve structures of the skin of mammals might at least have been allowed to shed some light upon this subject.

Dr. Kidd finds an interesting imbricated form of ridge structure occurring somewhat sporadically not only in man, but in occasional cases of the lower primates. Also in the case of the lower mammals a few individuals were found in which occurred similar imbrication of the papillæ of the corium. This imbrication is in no case a specific character; it is in some cases proximal, in others distal even upon the same region, though there seems to be a certain degree of constancy in direction in man, at least, the imbrication on the finger tips, when it occurs, being more often distal, and on the hallucal region of the foot, proximal.

In part III. the author strongly adheres to the view of Schlaginhaufen that the ridged form of epidermis has essentially and primarily a tactile function instead of the mechanical one first suggested by Hepburn, and later elaborated by Miss Whipple. This latter writer, whose views Dr. Kidd strenuously attempts to refute, believes that the ridges are formed by the coalescence of epidermic units (modified scales) in response to external pressure conditions, and that they perform the function of presenting a roughened surface to increase friction and thus prevent slipping either in walking or prehension, hence the term "friction skin." According

to this interpretation there is no attempt to minimize the importance of the general tactile function of the regions in question, since in the very nature of the case they are especially exposed to contact with external objects. The arrangement of the papillæ of the corium in double rows underlying the ridges is, however, regarded as merely incident to the fact that, in the primate type at least, enormously large sweat glands are arranged in a row underlying each ridge and opening upon its surface, thus by their secretion adding greatly to the efficiency of the friction skin in prehension. Of necessity, then, the papillæ must occupy the only remaining space, which is upon either side of the line of sweat glands and hence follows also the course of the ridges.

After this brief exposition of the view which Dr. Kidd would refute, let us return to his arguments. He makes no attempt whatever to account for the large number and great size of the sweat glands associated with the ridges; but from the fact that the papillæ, many of which are indeed merely vascular, are arranged in rows underlying the ridges, he argues that the ridges themselves must be tactile organs. Neither does he seem to see that the great thickness of the epidermis over ridged areas (which certainly can not be for the purpose of increasing the sensitiveness of the skin) must in part account for the necessity for more numerous and taller papillæ than in more thinly covered regions of equal sensitiveness. It is just at this point that we feel the author's mistake in not including in his work a careful study of the nerve structures of the skin.

Neither is there any satisfactory experimental basis presented to show that the external epidermic ridged structure actually does add to the tactile function. This is, indeed, a point upon which such trustworthy experimental psychologists as Stern and Féré absolutely disagree. The only possible relationship which any one has attempted to establish between the direction of the ridges and the sensitiveness of the surface is that referred to by Dr. Kidd, which lies in the fact that two points seem to be more readily distinguished when so placed that a line joining them is at

right angles to the general course of the ridges. The author apparently does not see, however, that such a result is quite in accord with the very ideas which he is trying to refute. Miss Whipple has shown that the friction ridges are so arranged as to be at right angles to the usual direction of pressure, and naturally the correlated tactile function would tend to be most highly developed along these same lines of pressure. This, indeed, is very probably purely the result of practise; for the experiments of Volkmann and Dresslar have shown that a given region of the skin has power to increase in sensitiveness by practise to an extent far exceeding the slight differences in sensitiveness which seem to be associated with the direction of the ridges. The fact that many ridged areas, such as, for example, the ball of the foot, where the ridges are markedly high and distinct and the patterns which they form are very complex and varied, are found to be low in the scale of relative sensitiveness should in itself show that the ridges serve primarily a mechanical and not a tactile function.

Dr. Kidd brings forward a list of instances in which ridges are formed upon unaccustomed places, where, he says, they can have no prehensile function. However, as he himself is forced to intimate, these instances of ridge formation can certainly be attributed to the influence of external pressure, and there is no doubt that many of them are valuable observations showing that ridges do form in response to such pressure. Certainly some of the regions mentioned do not possess a degree of sensitiveness which would justify the creation of highly specialized sense organs.

Others of Dr. Kidd's arguments are so plainly fallacious that they need only be mentioned. For instance, he says, "arches, loops, and whorls represent degrees of departure from the primitive arrangement, and enable a larger area of ridge-covered surface to be exposed to contact relatively to the size of the part." One can hardly see how the form of pattern can increase the area of the surface, provided that in each case the surface is covered with ridges.

Again he argues: "The pulps of man's fingers have highly developed patterns, and these are more variable and complex than those of any other part of any of the primates, and these are the most sensitive areas in any hand or foot. In this instance the connection between sensibility and complexity of pattern of ridges is intimate. The pulps of the toes in man are less sensitive than those of the fingers, and the patterns of the second, third, fourth and fifth digits simple, and these digits are relatively weak in function compared with the hallux." One has only to turn over the pages of Dr. Kidd's own book to see many illustrations of patterns on the interdigital and proximal pads of monkeys which represent not only perfect whorls, but many other very intricate and complicated patterns. Furthermore, in the study of many hundreds of human hands and feet, the most complicated patterns which the reviewer has found have been upon the apical pads of all five of the toes; these patterns are, however, very large and one must study the lateral sides of the digit as well as the mere contact surface, in order to appreciate them.

The author presents, also, as an argument in favor of the tactile function of the ridges, the fact of their imbrication above referred to. This, he avers, must have some important significance in relation to the sense of touch, though he is unable to show how. It is a little surprising that so strong a Lamarckian as he has shown himself to be by his previous writings should fail to see, in this imbrication, a Lamarckian character due to external pressure, a pressure which would be the resultant of the shape of the surface and the amount and kind of use of the region involved. Two cases cited in which the imbrication has a definite relationship to the center of the core of the pattern, being toward the center in one case and away from it in the other, would thus find a possibility of explanation; while on the basis of some important tactile function the two cases absolutely defeat each other.

As a whole the book is a timely contribution to a subject which has recently come into renewed prominence, and with its excellent illustrations and extensive bibliography, is

valuable as a source of general information on the subject.

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SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 201st meeting of the society, held in the Cosmos Club, on Wednesday evening, February 26, the following papers were presented:

Regular Program

Evidences of Recent Volcanic Activity and the Glaciers of Mt. Hood, Oregon: A. H. SYLVESTER.

Mt. Hood, the highest mountain in Oregon and one of the most beautiful of the ice-covered extinct volcanoes of the Cascade Range, lies on the crest of that range about 20 miles south of the Columbia River. Its elevation is 11,225 feet. About two thirds of its crater remains, the southwest side being broken away.

The evidence of field observations and the new topographic map made by the writer last summer point to a very extensive glaciation at some former period, and to another less extensive advance in comparatively recent times.

An enormous mass of morainal material covers the southwest flanks of the mountain and nearly fills three of its large canyons. This was probably derived from the cutting away of the crater by the early glaciation. The Zigzag and White River glaciers now head against the inside of the north wall. They have cut away the old crater floor and exposed the volcanic neck or plug which now stands a prominent feature in the center of the ruined crater and is known as Crater Rock.

A section exposed in White River Canyon by the cutting of the present streams through the morainal filling shows two layers of drift separated by a layer of soil and logs in place, and ten or twenty feet of fossil ice underlying all. There are eight glaciers of fair size on the mountain. On the whole, they are probably receding, but owing to several recent

heavy winters there now appears to be an advance.

The Zigzag and White River glaciers are exceptions to this rule, because of volcanic heat. Their lower ends are disintegrating and opposite Crater Rock, the point of greatest volcanic activity, the Zigzag is partially and the White River wholly cut in two.

On August 28, 1907, in addition to the usual steam, smoke was seen issuing from Crater Rock and at night a glow was observed. The next day the White River was trebled in volume without other warrant than the mountain's internal heat.

No alarming symptoms have been observed since.

Physical Features of Peru: GEO. I. ADAMS.

Peru is generally considered as containing three regions: the coast, the sierra and the montaña or forest. These regions differ climatically, the coast is arid and agriculture is carried on by means of irrigation. The sierra has a moderate rainfall and being an elevated region evaporation is great, so that the climate is semi-arid. The forest region has a heavy rainfall and is covered with a tropical forest.

The coast region is a narrow belt. In the northern, south-central and southern portions there are coastal plains. The extent of these plains was shown for the first time on the maps accompanying Mr. Adams's reports of his reconnaissance of the coast, published as bulletins of the Corps of Engineers of Mines of Peru. Between the northern and south-central plains and likewise between the south-central and southern plains the mountains descend to the sea. Between the southern plains and the sea there is a range of coast hills. The coastal plains are occupied by Tertiary formations.

The division between coast and sierra is dependent upon elevation, not upon topography, and corresponds with the limit of general annual rainfall excepting to the northward, where the rainfall extends over a portion of the coastal plains in the region of the Gulf of Guayaquil. The approximate limit of the annual rainfall is shown on Mr. Adams's maps.